GLX Power Systems Inc.

Intelligent Energy Storage and Power Management System

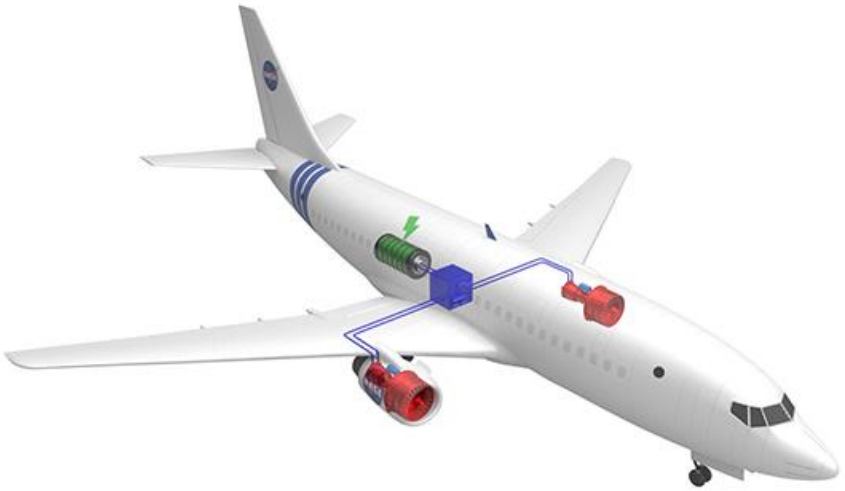
Unified Cognicell® Powered™ Electric Aircraft Propulsion (EAP) solution

GLX Power Systems Inc.
Kent Kristensen
46 Chagrin Plaza # 201
Cleveland Ohio 44022-3022 USA
P: +1.440.338.6526
E: kkristensen@glxpower.com
www.glxpower.com

Cognicell™ is a patented and trademarked ***intelligent multilevel power converter and energy storage management subsystem*** enabling software-defined functionality within smart battery packs, energy magazines, fuel-cell systems and renewable energy systems.

Cognicell™ uniquely ***unify traditional power electronics***, simplify system design, increase energy efficiency, improve performance-, durability-, reliability- and safety while streamlining the supply chain and manufacturing, eliminating SKU's and spares. Also increasing useful life and reducing cost of next generation products/platforms.

Cognicell Powered MW-Class EAP aircraft



Proposed Design

GLX Design

Cognicell Powered Aircraft Electrical System

- Simplify balance of system; fewer boxes, shorter wiring, less cooling, reduce points of failure
- Eliminate stand-alone power converters, inverters, motor drives, controllers and cooling systems saving weight, increasing energy efficiency and improving overall reliability
- Add more cells to improve performance, reliability, safety and operational endurance without compromising weight/space (SWAP-C)
- Distribute battery and power electronics throughout structure of aircraft; better thermal management and place battery terminations in vicinity of e-motors
- Unified Software Defined Power Electronics:
  - ❑ Intelligent Energy Storage and Active Battery Management System (BMS):
    - enable better monitoring, utilization and resting of battery cells, allow for more efficient use of available cell capacity (“overhead”), reprogram electronics for new cell types
    - enable cell-level redundancy and emergency shut-off, prevent thermal runaway
    - allow battery with single or multiple faulty cells to continue operating before switching to redundant battery
    - monitor individual cells, log cell level data, replace/service battery cells or modules; not entire batteries
  - ❑ Electric Motor Drive and Controller (electric propulsion system):
    - separate battery and/or fuel-cell subsystems for each e-motor, improve operational redundancy and reliability
    - improve efficiency, range and operational endurance as well as better e-motor integration

Scalable Multilevel Converter and Power Management Platform

COGNICELL

REMOTE
- Maintenance
- Monitoring
- Shutdown

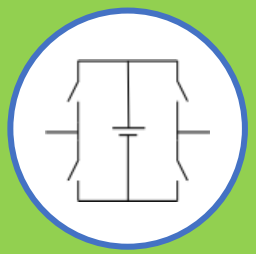
SOFTWARE
- Charge Control
- Discharge Control
- Fault Isolation

REAL TIME:
Balancing, Equalizing,
System Functionality

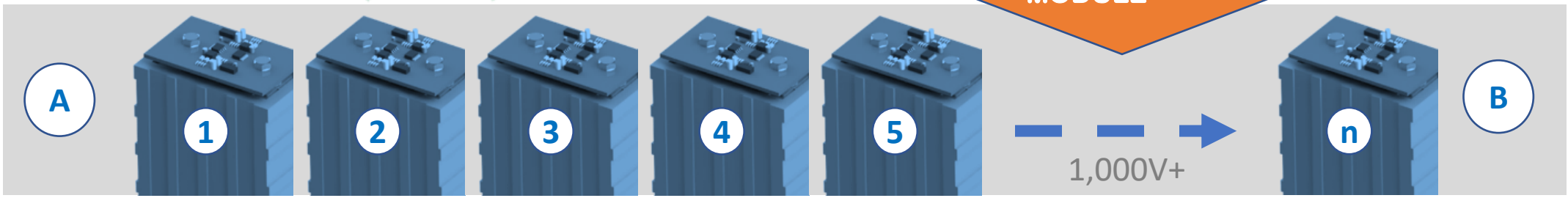
HARDWARE
- Cell-level Control
- Cell-level Safety

POLARITY:
Cell Agnostic, Positive
Negative. Open or bypass

COGNICELL™ NODE
- Full Bridge
- Half Bridge

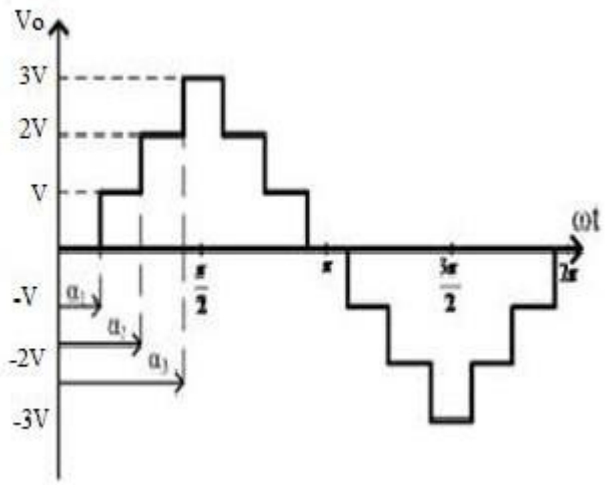


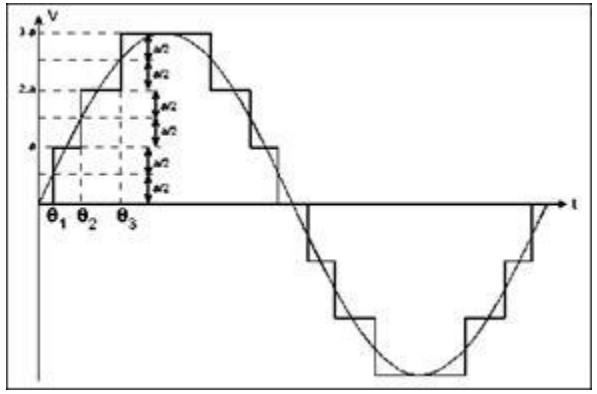
COGNICELL™ MODULE



Cascaded Multilevel Power Converter/Inverter

Using variable output, and overlaying a sinewave generator in software, we create clean AC out of the battery….



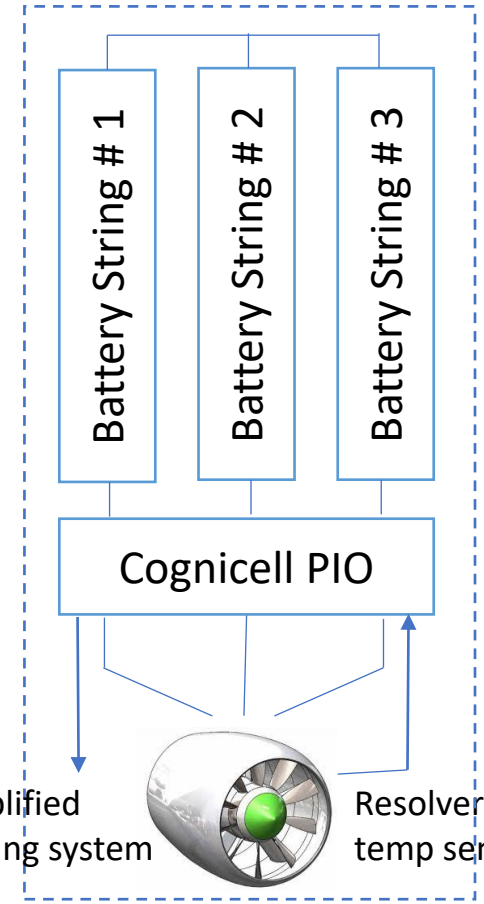


- Building a sinewave one cell at the time, neutral, positive, neutral and negative provides a smooth sinewave
- Handling active battery cell management, balancing and equalizing at the same time
- AC operations can apply to both discharging or transformerless charging
- Add software-defined functionality with internal or external system control (e.g., motor drive or grid-tie)

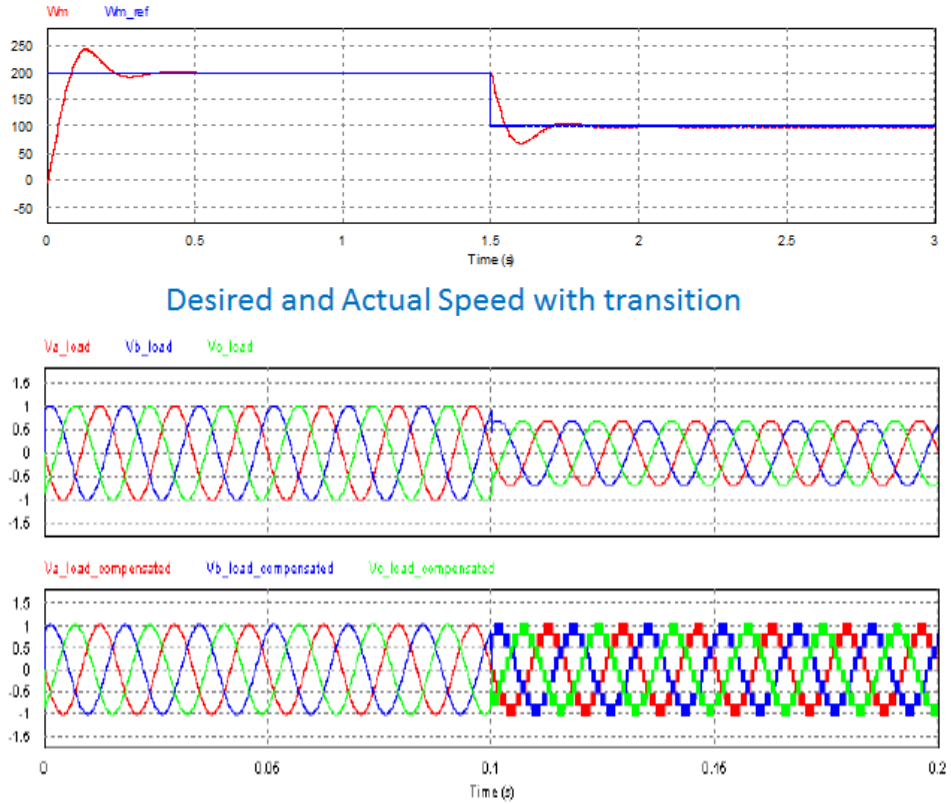
Software-defined battery – AC or DC out!

Electric Vehicle Motor Control or Grid-tie

Cognicell® Powered™ e-motor drive (example)

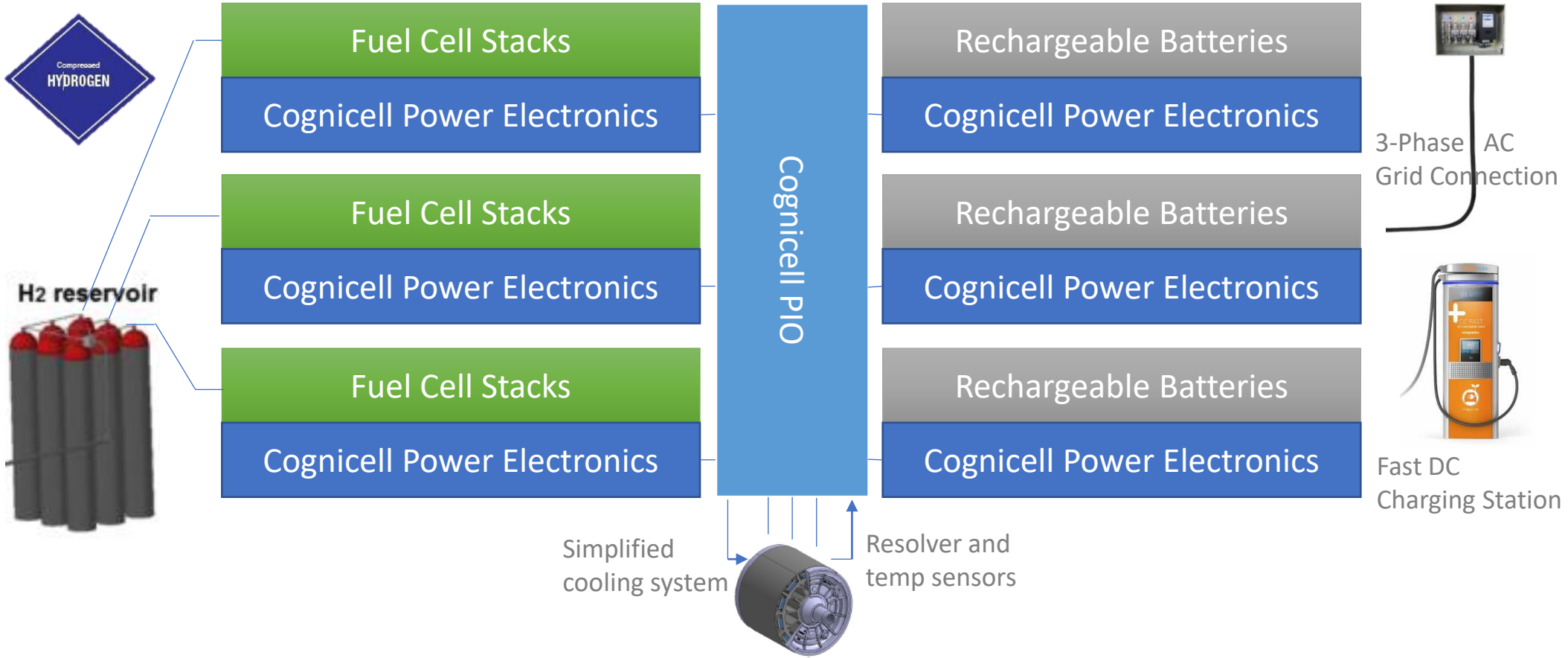


Cognicell™ Simulation for PMSM Stator Voltages



3-Phase (3Ø) output w/Amplitude or Frequency e-motor control

Unified Cognicell BEV-FEV System Topology



Software-defined functionality

(CASE STUDY)

Smart High Voltage EV Battery Pack:

- Software-defined power: variable frequency & magnitude AC output/input, variable DC input/output, regenerative breaking, reconfigure for grid-connected environment.
- Reconfigure Pack: serialize 3 x 800V discharge strings (driving the 3-phase AC e-motor) to high-voltage J1772/CCS fast DC charging. Next-gen platform 3 x 800V (1,600V) → Charge @ 800V.
- Improving application reliability: by removing/bypassing failing or defective cells.
- Improve efficiency: by decreasing switching frequency through using cascaded multi-level inverter techniques. Also, in doing so distribute thermal dissipation across several switches and parallel MOSFETs to increase power range and reduce inline losses.
- Thermal runaway back-up protection: by resting and disabling failing cells in advance and before occurrence or (optionally) shunting energy from an internal short through external switches.
- Less ≤ 2% THD: due to a more harmonic voltage excitation. No spurious switching frequencies. Improve motor performance and reliably. Dynamic motor feedback and control.
- Motor drive and control: direct AC motor drive and control from battery pack incl. resolver & temp feedback. Integrated battery and motor cooling.

Embedded Solution

Intelligent energy storage

COGNICELL

US20140312828A1 (issued)
US2017054306A1 (issued)
US2018126675A1 (issued)
US2019450274A1 (Issued)
EP2973935B1 (issued)
JPO2019006658 (Issued)
IPO329297 (issued)
WTP90127314 (issued)
WTP90127334 (issued)

GLX Power Systems Inc.
USA 46 Chagrin Plaza # 201
HQ: Cleveland Ohio 44022-3022 USA

EU: Lyskaer 3EF
DK-2730 Herlev DENMARK

www.glxpower.com

Kent Kristensen
P: +1.440.338.6526
S: kristensen.kent
E: kkristensen@glxpower.com

Thank you!